Disorder-induced losses in photonic crystal waveguides

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Photonic modes lying below the light line in photonic crystal (PhC) slabs are truly guided and their propagation losses follow from the presence of structural disorder. In this work, a model for disorder-induced losses in PhC slabs is studied. The model consists of assuming a random distribution of hole (or pillar) radii, described by a Gaussian function. The model is applied to the calculation of propagation losses in various high-index contrast PhC slabs containing line-defect waveguides. In particular, we consider W1-type waveguides (i.e., a missing row of holes along the ΓK direction of the triangular lattice with lattice constant a) in a high-index membrane and show that propagation losses are substantially reduced by increasing the channel width from $w=w_0\equiv\sqrt{3}a$ (W1) to $w=1.5w_0$ (W1.5 waveguide), while maintaining a monomode propagation region. We also consider linear waveguides in the square lattice of dielectric pillars and compare the propagation losses with those measured in recent experiments [M. Tokushima et al., APL 84, 4298 (2004)]. A comparison between the roles of disorder in hole and pillar lattices is also discussed.